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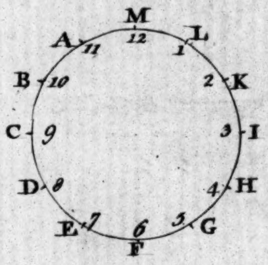

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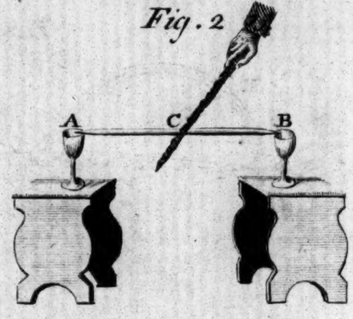

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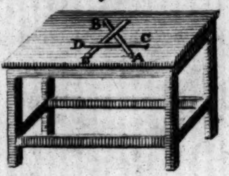

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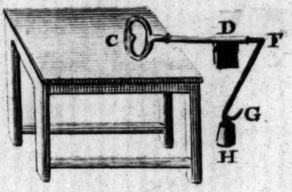

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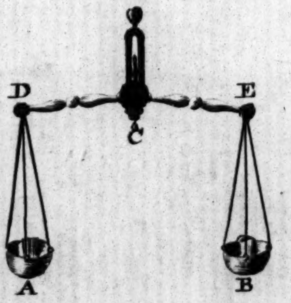

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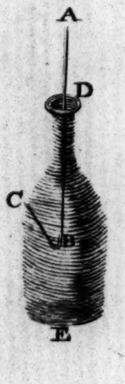

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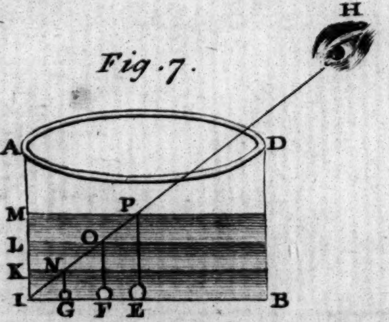

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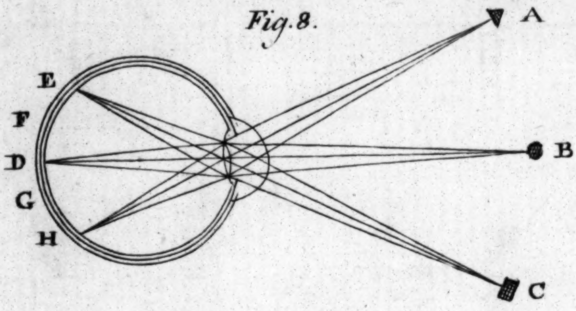

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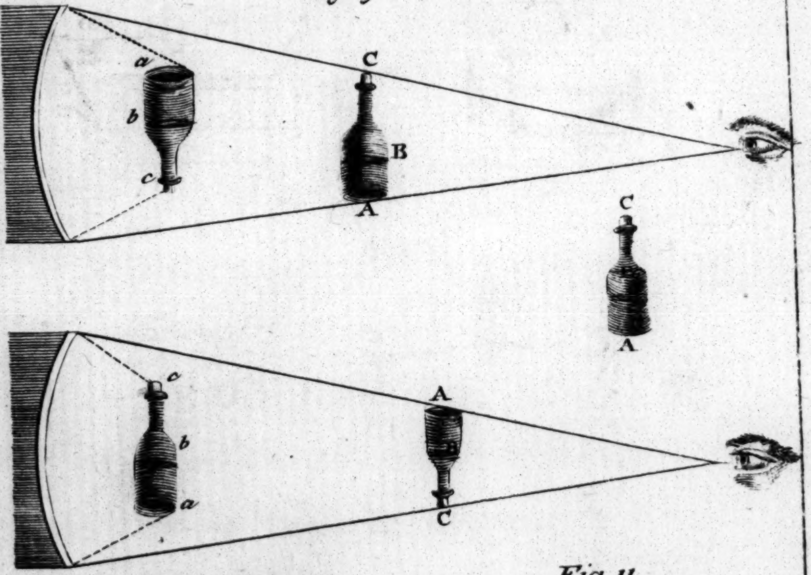

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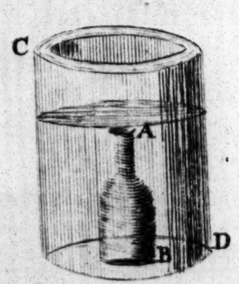

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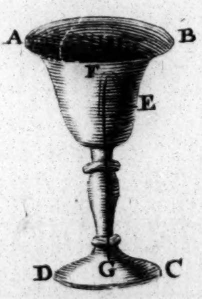

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OR,

EASY AND INSTRUCTIVE

RECREATIONS

FOR

YOUNG PEOPLE.

THE SECOND EDITION, CORRECTED AND IMPROVED.

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BRITISH MUSEUM

PREFACE.

IT is generally allowed, by thoſe who have had the care and education of youth, that the moſt effectual method of engaging their attention, to any particular branch of knowledge, is to render it familiar and entertaining, by repreſenting to them, as often as poſſible, ſome of it's moſt curious and intereſting properties. Thus the mind, which is naturally fond of novelty, and delighted with new acquiſitions, is inſenſibly led to more important purſuits, and not unfrequently receives a bent, which is productive of the moſt ſolid advantages through life.

IN order that young people may be provided with proper amuſements for their leiſure hours, the Editor of the preſent performance has been induced to make a ſhort collection of the moſt curious Experiments and Recreations, in various branches of ſcience, and to render them as eaſy and perſpicuous as poſſible. With this view, ſuch only have been choſen, as appeared moſt likely to afford pleaſure and information; and the whole is methodized and arranged in ſuch a manner, as it is preſumed will be found perfectly ſatisfactory and commodious.

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SELECT RECREATIONS.

I.

A Perſon having an even Number of Counters in one Hand, and an odd Number in the other, to tell in which Hand each of them is.

DESIRE the perſon to multiply the number in his right hand by three, and the number in his left by two.

Bid him add the two products together, and tell you whether the ſum be odd or even.

If it be even, the even number is in the right hand; but if it be odd, the even number is in the left hand.

EXAMPLE I.

No. in right hand.	No. in left hand.
18	7
3	2
54	14

54
14
68 ſum of the products.

EXAMPLE II.

No. in right hand.	No. in left hand.
7	18
3	2
21	36

36
21
57 ſum of the products.

II.

A Perſon having fixed on a Number in his Mind, to tell him what Number it is.

Bid him quadruple the number thought on, or multiply it by 4, and having done this, deſire him to add 6, 8, 10, or any even number you pleaſe, to the product; then let him take the half of this ſum, and tell you how much it is; from which, if you take away half the number you deſired him at firſt to add to it, there will remain the double of the number thought on.

EXAMPLE.

Suppoſe the number thought on is - - -	5
The quadruple of it is - - - - - - - - -	20
8 added to the product is - - - - - - -	28
And the half of this ſum is - - - - - -	14
4 taken from this leaves - - - - - - -	10

therefore 5 was the number thought on.

Another Method of diſcovering a Number thought on.

After the perſon has fixed on a number, bid him double it, and add 4 to that ſum; then let him multiply the whole by 5, and to that product add 12; deſire him alſo to multiply this ſum by 10, and after having deducted 302 from the product, to tell you the remainder, from which, if you cut off the laſt two figures, the number that remains will be the one thought on.

EXAMPLE.

Let the number thought on be - -	7
Then the double of this is - - - - -	14

And 4 added to it makes - - - - -	18
This multiplied by 5 is - - - - -	90
And 12 added to it is - - - - - -	102
And this multiplied by 10 is - - -	1020
From which deducting - - - - - -	302
There remains - - - - - - - - -	718

which by ſtriking off the laſt two figures gives 7 the number thought on.

III.

To tell the Number a Perſon has fixed upon, without aſking him any Queſtions.

THE perſon having choſen any number in his mind, from 1, to 15, bid him add 1 to it, and triple the amount. Then

1. If it be an even number, let him take the half of it, and triple that half; but if it be an odd number, he muſt add 1 to it, and then halve it, and triple that half.

2. In like manner let him take the half of this number, if it be even, or the half of the next greater, if it be odd; and triple that half.

3. Again, bid him take the half of this laſt number, if even, or of the next greater, if odd; and the half of that half in the ſame way; and by obſerving at what ſteps he is obliged to add 1 in the halving, the following table will ſhow the number thought on:

1—0—0	-	4—8
2—0—0	-	13—5
3—0—0	-	3—11

1—2—0	2—10
1—3—0	8— 0
1—2—3	6—14
2—3—0	1— 9
0—0—0	15— 7

Thus, if he be obliged to add 1 only at the firſt ſtep, or halving, either 4 or 8 was the number thought on; if there were a neceſſity to add 1 both at the firſt and ſecond ſteps, either 2 or 10 was the number thought on, &c.

And which of the two numbers is the true one may always be known from the laſt ſtep of the operation; for if 1 muſt be added before the laſt half can be taken, the number is in the ſecond column, or otherwiſe in the firſt, as will appear from the following examples:

Suppoſe the number choſen to be	9
To which if we add	1
The ſum is	10
Then the triple of that number is	30
1. The half of which is	15
The triple of 15 is	45
* 2. And the half of that is	23
The triple of 23 is	69
* 3. The half of that is	35
And the half of that is	18*

From which it appears that it was neceſſary to add 1 both at the ſecond and third ſteps, or halvings, and therefore by the table the number thought on is either 1 or 9.

And as the laſt number was obliged to be augmented by 1 before the half could be taken, it follows alſo, by the above rule, that the number muſt be in the ſecond column; and conſequently it is 9.

Again, ſuppoſe the number thought on to be 6
To which if we add - - - - - - - - - 1
The ſum is - - - - - - - - - - - - - 7
Then the triple of that number is - - - 21
*1. The half of which is - - - - - - - - - 11
The triple of 11 is - - - - - - - - - - 33
*2. And the half of that is - - - - - - - - 17
The triple of 17 is - - - - - - - - - - 51
*3. The half of that is - - - - - - - - - 26
And the half of that half is - - - - - - 13

From which it appears that it was neceſſary to add 1 at all the ſteps, or halvings, 1, 2, 3, therefore, by the table, the number thought on is either 6 or 14.

And as the laſt number required no augmentation before it's half could be taken, it follows alſo, by the above rule, that the number muſt be in the firſt column; and conſequently it is 6.

IV.

A curious Recreation, uſually called the Blind Abbeſs and her Nuns.

A BLIND abbeſs viſiting her nuns, who were 24 in number, and equally diſtributed in 8 cells, built at the four corners of a ſquare, and in the middle of each ſide, finds an equal number in every row, containing three cells. At a ſecond viſit, ſhe finds the ſame number of perſons in each row as before, though the company was increaſed by the acceſſion of four men. And coming a third time, ſhe ſtill finds the ſame number of perſons in each row, though the four men were then gone, and had each of them carried away a nun with them.

Fig 1.

3	3	3
3		3
3	3	3

Fig. 2.

2	5	2
5		5
2	5	2

Fig. 3.

4	1	4
1		1
4	1	4

Let the nuns be firſt placed as in fig. 1. 3 in each cell; then when the four men have gotten into the cells, there muſt be a man placed in each corner, and two nuns removed thence to each of the middle cells, as in fig. 2; in which caſe there will evidently be ſtill nine in each row; and when the four men are gone, with the four nuns with them, each corner cell muſt contain four nuns, and every other cell one, as in fig. 3; it being evident, that in this caſe alſo, there will ſtill be nine in a row, as before.

V.

Any Number being named, to add a Figure to it, which ſhall make it diviſible by 9.

Add the figures together in your mind, which compoſe the number named; and the figure which muſt be added to this ſum, in order to make it diviſible by 9, is the one required.

Suppoſe, for example, the number named was 8654; you find that the ſum of it's figures is 23; and that 4 being added to this ſum will make it 27; which is a number exactly diviſible by 9.

You therefore deſire the perſon who named the number 8654, to add 4 to it, and the reſult, which is 8658, will be diviſible by 9, as was required.

This recreation may be diverſified, by your ſpecifying, before the ſum is named, the particular place where the figure ſhall be inſerted, to make the number diviſible by 9; for it is exactly the ſame thing, whether the figure be put at the end of the number, or between any two of it's digits.

VI.

A Perſon having made Choice of ſeveral Numbers, to tell him what Number will exactly divide the Sum of thoſe which he has choſen.

Provide a ſmall bag, divided into two parts; into one of which put ſeveral tickets, numbered 6, 9, 15, 36, 63, 120, 213, 309, or any others you pleaſe that are diviſible by three, and in the other part put as many different tickets marked with the number 3 only.

Draw a handful of tickets from the firſt part, and, after ſhowing them to the company, put them into the bag again; and having opened it a ſecond time, deſire any one to take out as many tickets as he thinks proper.

When he has done this, open privately the other part of the bag, and tell him to take out of it one ticket only.

You may then pronounce, that this ticket ſhall contain the number by which the amount of the other numbers is diviſible; for, as each of theſe numbers is ſome multiple of 3, their ſum muſt evidently be diviſible by that number.

This recreation may alſo be diverſified, by marking the tickets in one part of the bag with any numbers which are diviſible by 9, and thoſe in the other part of the bag with the number 9 only; the properties of both 9 and 3 being the ſame; or if the numbers in one part of the bag be diviſible by 9, the other part of the bag may contain tickets marked both with 9 and 3, as every number diviſible by 9 is alſo diviſible by 3.

VII.

To find the Difference between any two Numbers, the greater of which is unknown.

TAKE as many nines as there are figures in the leſs number, and ſubtract the one from the other.

Let another perſon add that difference to the larger number: and then, if he take away the firſt figure of the amount, and add it to the remaining figures, the ſum will be the difference of the two numbers, as was required.

Suppoſe, for example, that Matthew, who is twenty-two years of age, tells Henry, who is older, that he can diſcover the difference of their ages.

He privately deducts 22, his own age, from 99, and the difference, which is 77, he tells Henry to add to his age, and to take away the firſt figure from the amount.

Then if this figure, ſo taken away, be added to the remaining ones, the ſum will be the difference of their ages, as for inſtance:

The difference between Matthew's age and 99, is - - - - - - - -	77
To which Henry adding his age -	35
The ſum will be - - - - - - - -	112
And 1, taken from 112, gives - -	12
Which being increaſed by - - - - -	1
Gives the difference of the two ages -	13
And this added to Matthew's age - -	22
Gives the age of Henry, which is - -	35

VIII.

A Perſon ſtriking a figure out of the Sum of two given Numbers, to tell him what that Figure was.

SUCH numbers muſt be offered as are diviſible by 9; ſuch, for inſtance, as 36, 63, 81, 117, 126, 162, 207, 216, 252, 261, 306, 315, 360, and 432.

Then let a perſon chooſe any two of theſe numbers, and after adding them together in his mind, ſtrike out any one of the figures he pleaſes, from the ſum.

After he has done this, deſire him to tell you the ſum of the remaining figures; and that number which you are obliged to add to this amount, in order to make it 9, or 18, is the one he ſtruck out.

For example, ſuppoſe he choſe the numbers 126, and 252, the ſum of which is 378.

Then, if he ſtrike out 7 from this amount, the remaining figures, 3 and 8, will make 11; to which 7 muſt be added to make 18.

If he ſtrike out the 3, the ſum of the remaining figures, 7 and 8, will be 15; to which three muſt be added, to make 18: and ſo, in like manner, for the 8.

IX.

By knowing the laſt Figure of the Product of two Numbers, to tell the other Figures.

If the number 73 be multiplied by each of the numbers in the following arithmetical progreſſion, 3, 6, 9, 12, 15, 18, 21, 24, 27, the products will terminate with the nine digits, in this order, 9, 8, 7, 6, 5, 4, 3, 2, 1; the numbers themſelves being as follows, 219, 438, 657, 876, 1095, 1314, 1533, 1752, and 1971.

Let therefore a little bag be provided, conſiſting of two partitions, into one of which put ſeveral tickets, marked with the number 73; and into the other part, as many tickets numbered 3, 6, 9, 12, 15, 18, 21, 24, and 27.

Then open that part of the bag which contains the number 73, and deſire a perſon to take out one ticket only; after which, dexterouſly change the opening, and deſire another perſon to take a ticket from the other part.

Let them now multiply their two numbers together, and tell you the laſt figure of the product, and you will readily determine, from the foregoing ſeries, what the remaining figures muſt be.

Suppoſe, for example, the numbers taken out of the bag were 73, and 12; then, as the product of theſe two numbers, which is 876, has 6 for it's laſt figure, you will readily know that it is the fourth in the ſeries, and that the remaining figures are 87.

X.

A curious Recreation with a hundred Numbers, uſually called the Magical Century.

If the number 11 be multiplied by any one of the nine digits, the two figures of the product will always be alike, as appears from the following example:

11	11	11	11	11	11	11	11	11
1	2	3	4	5	6	7	8	9
11	22	33	44	55	66	77	88	99

Now, if another perſon and yourſelf have fifty counters apiece, and agree never to ſtake more than ten at a time, you may tell him, that if he will permit you to ſtake firſt, you will always undertake to make the even century before him.

In order to this you muſt firſt ſtake one, and, remembering the order of the above ſeries, conſtantly add to what he ſtakes as many as will make one more than the numbers 11, 22, 33, &c., of which it is compoſed, till you come to 89; after which, the other party cannot poſſibly make the even century himſelf, or prevent you from making it.

If the perſon who is your opponent have no knowledge of numbers, you may ſtake any other number firſt, under 10, provided you afterwards take care to ſecure one of the laſt terms, 56, 67, 78, &c.: or you may even let him ſtake firſt, provided you take care afterwards to ſecure one of theſe numbers.

This recreation may be performed with other numbers; but, in order to ſucceed, you muſt divide the number to be attained, by a number which is an unit greater than what you can ſtake each time; and the remainder will then be the number you muſt firſt ſtake. Suppoſe, for example, the number to be attained is 52, (making uſe of a pack of cards inſtead of counters,) and that you are never to add more than ſix; then dividing 52 by 7, the remainder, which is 3, will be the number you muſt ſtake firſt; and whatever the other ſtakes, you muſt add as much to it as will make it equal to 7, the number by which you divided; and ſo on.

XI.

Two Dice being thrown, to find the Number of Points on each Die, without ſeeing them.

After any perſon has thrown two dice, upon a table, bid him double the number of points on one of them, and add 5 to it; then let him multiply this ſum by 5, and add the number of points on the other die to it. This being done, deſire him to tell you the ſum, and having thrown out of it 25, the remainder will be a number conſiſting of two figures, the firſt of which, to the left, is the number of points on the firſt die, and the ſecond figure, to the right, the number on the other.

Suppoſe, for example, that the number of points of the firſt die which comes up, is 2, and that of the other 3; then if to 4, the double of the points of the firſt, there be added 5, and the ſum, which is 9, be multiplied by 5, the product will be 45; to which if we add 3, the number of the points on the other die, it will make 48. Then, if 25 be thrown out of this number, the remainder is 23; the firſt figure of which, 2, is the number of points of the firſt die, and the ſecond figure, 3, the number of the other.

XII.

To find the Number of Deals a Perſon may play at the Game of Whiſt, without holding the ſame Cards twice.

In all combinations, if from an arithmetical decreaſing ſeries, the firſt term of which is the number out of which the combinations are to be formed, and the common difference of which is 1, there be taken as many terms as there are quantities to be combined, and theſe terms be multiplied into each other; and if from the ſeries 1, 2, 3, 4, &c., there be taken the ſame number of terms, and theſe be multiplied into each other; the quotient ariſing from the diviſion of the firſt product by the ſecond, will be the number of combinations required.

Now as the number of cards played with at whiſt amounts to 52, and of theſe 13 are dealt to each perſon, we are to find how many different combinations of 13 can be formed out of 52. Conformably to the rule, therefore, multiply 52 ſeverally by 51, 50, 49, and ſo on to 41, which will give 3954242643911239680000 for the product. Then multiply 1, 2, 3, &c., to 13, into each other, and the product will be 6227020800. The former product being divided by the latter will give 635013559600 for a quotient, which is the number of different ways 13 cards may be taken out of 52, and conſequently the number required.

A queſtion, ſomething ſimilar to this, though much more difficult to be reſolved, is, to determine the number of fifteens that may be made, as in the game of cribbage, out of a common pack of 52 cards, which is found, by computation, to be no leſs than 17264.

XIII.

To tell by the Dial of a Watch, at what Hour any Perſon intends to riſe.

Desire the perſon to ſet the hand of the dial to any hour he pleaſes, to which number, when he has informed you what it is, add in your mind 12.

After this, tell him to call the hour the index ſtands at that which he has fixed upon; and by reckoning backwards from this number to the former, it will bring him to the hour required.

EXAMPLE.

Suppose the hour at which he intends to riſe be 8, and that he has placed the hand at 5.

Then, adding 12 to 5, you bid him call the hour at which the index ſtands, the number on which he thought; and by reckoning back from this number to 17, it will bring him to 8, the hour required.

This recreation may alſo be performed as follows: let 12 cards be placed in a circular order as in fig. 1, ſo that an ace may correſpond with A, a duce with B, and ſo on to L and H, the firſt of which muſt be a queen, and ſtand for 11, and the ſecond a king, and ſtand for 12; having done this, ſo that you can recollect the ſituation of the cards, deſire any perſon to put his hand on one of them, and think on the hour at which he intends to riſe; then, adding 12 to the number of this card, in your mind, bid him count backwards, from the hour he thought on, to this number, and he will come to a card, which, being turned up, ſhows the number required.

XIV.

Thirty Soldiers having deſerted, ſo to place them in a Ring, that you may ſave any 15 you pleaſe, and it ſhall ſeem the Effect of Chance.

THIS recreation is uſually propoſed thus: 15 chriſtians and 15 turks being in a ſhip at ſea, in a violent tempeſt, it was deemed neceſſary to throw half the number of perſons overboard, in order to diſburden the ſhip, and ſave the reſt; to effect this, it was agreed to be done by lot, in ſuch a manner, that the perſons being placed in a ring, every ninth man ſhould be caſt into the ſea, till one half of them were thrown overboard. Now the pilot, being a chriſtian, was deſirous of ſaving thoſe of his own perſuaſion: how ought he therefore to diſpoſe the crew, ſo that the lot might always fall upon the turks?

This queſtion may be reſolved by placing the men according to the numbers annexed to the vowels in the words of the following verſe;

Po-pu-le-am Jir-gam Ma-ter Re-gi-na fe-re-bat
4 5 2 1 3 1 1 2 2 3 1 2 2 1

from which it appears, that you muſt place four of thoſe you would ſave firſt; then five of thoſe you would puniſh. After this, two of thoſe to be ſaved, and one to be puniſhed; and ſo on. When this is done, you muſt enter the ring, and beginning with the firſt of the four men you intend to ſave, count on to nine; and turn this man out to be puniſhed; then count on, in like manner, to the next ninth man, and turn him out to be puniſhed; and ſo on for the reſt.

It is reported that Joſephus, the author of the Jewiſh Hiſtory, eſcaped the danger of death by means of this problem; for being governor of Joppa, at the time that it was taken by Veſpaſian, he was obliged to ſecrete himſelf with thirty or forty of his ſoldiers in a cave, where they made a firm reſolution to periſh by famine rather than fall into the hands of the conqueror; but being at length driven to great diſtreſs, they would have deſtroyed each other for ſuſtenance, had not Joſephus perſuaded them to die by lot, which he ſo ordered, that all of them were killed except himſelf and another, whom he might eaſily deſtroy, or perſuade to yield to the romans.

XV.

Three Perſons having each choſen privately one out of three Things, to tell them which they have choſen.

LET the three things, for inſtance, be a ring, a guinea, and a ſhilling, and let them be known privately to yourſelf by the vowels *a*, *e*, *i*, of which the firſt, *a*, ſignifies one, the ſecond, *e*, two, and the third, *i*, three.

Then take 24 counters, and give the firſt perſon 1, which ſignifies *a*, the ſecond 2, which repreſent *e*, and the third 3, which ſtand for *i*; then, leaving the other counters upon the table, retire into another room, and bid him who has the ring take as many counters from the table as you gave him; he that has the guinea, twice as many, and he that has the ſhilling four times as many.

This being done, conſider to whom you gave one counter, to whom two, and to whom three; and as there were only twenty-four counters at firſt, there muſt neceſſarily remain either 1, 2, 3, 5, 6, or 7 on the table; or otherwiſe they muſt have failed in obſerving the directions you gave them.

But if either of theſe numbers remain, as they ought, the queſtion may be reſolved by retaining in your memory the ſix following words:

Salve	certa	anima	ſemita	vita	quies.
1.	2.	3.	5.	6.	7.

As for inſtance, ſuppoſe the number that remained was 5; then the word belonging to it is ſemita; and as the vowels in the firſt two ſyllables of this word, are *e* and *i*, it ſhows, according to the former directions, that he to whom you gave two counters has the ring, he to whom you gave three counters the gold, and the other perſon, of courſe, the ſilver, it being the ſecond vowel which repreſents 2, and the third which repreſents 3.

XVI.

To tell the Number of Pips upon any two Cards, which a Perſon ſhall draw from a whole Pack.

The ſmall cards are to be reckoned according to the number of their pips, and each pictured card for ten. This being agreed upon, let the perſon add as many more cards to each of thoſe he has drawn, as will make up it's number 25. Then take the remaining cards in your hand, and ſeeming to ſearch for ſome particular card, tell them over privately to yourſelf, and their number will be the amount of the two cards drawn.

For example; ſuppoſe the perſon had drawn a 10 and a 7; he muſt then add 15 cards to the firſt, to make the number 25; and 18 to the laſt, for the ſame reaſon. Then as 15 and 18 make 33, and the two cards themſelves 35; if this be deducted from 52, the number of the whole pack, it will leave 17, which muſt be the number of the remaining cards, and alſo of the two cards drawn.

This recreation may be performed without your touching the cards, thus:---let the perſon who has drawn two cards deduct the numbers of each of them from 26, and after adding the remainders together, deſire him to tell you the amount, which you privately deduct from 52, and the remainder will be the amount of the two cards.

But as the number 26 may lead to a diſcovery of the principle, on account of it's being half the pack, you may take any other number between 10 and 26 at pleaſure, as for inſtance, 24; then if you add 4, which is the double of the two you took from the 26, to the remainder, the difference between that ſum and 52 will be the amount of the two cards, as before, and in this way you may diverſify the recreation every time it is repeated.

XVII.

To diſcover the Number of Pips on any Number of Cards which a Perſon has privately taken from the whole Pack.

It is firſt to be agreed that the ace ſhall be 1, the court cards 10 each, and the others according to their number of pips.

Then deſire any one to chooſe as many cards as he thinks proper out of the whole pack, and over each of them to put as many other cards as will make the number of it's points 12.

After this, take the remaining part of the pack in your hand, and ſeeming to look for ſome card among them, count how many there are, and that amount, if the number of parcels taken were 4, will be the number of points on the three bottom cards. If the number of parcels exceed 4, add 13 to the remaining cards for each parcel above 4; if it be leſs than four, ſubtract from the cards remaining 13 for each parcel leſs than 4.

EXAMPLE.

SUPPOSE the perſon had choſen a 7, a 10, and an ace.

Then over the 7, he muſt place 5 cards; over the 10, 2; and over the ace, 11.

After this, he gives you the remaining part of the pack, which you find conſiſts of 31 cards.

From this 31, therefore, you deduct 13, and the remainder, 18, is the number of pips upon all the bottom cards.

XVIII.

Several Cards being ſhown to different perſons, that each of them may chooſe one, to name that which each Perſon has fixed on.

THERE muſt be as many different cards ſhown to each perſon as there are perſons to chooſe; ſo that if there be three perſons, you muſt ſhow to each of them three cards; and telling the firſt to retain one of them in his memory, you then lay thoſe three cards down, and ſhow three others to the ſecond perſon; and ſo to the third.

This being done, take up the firſt perſon's cards, and lay them down one by one, ſeparately, with their faces uppermoſt. You next place the ſecond perſon's cards over thoſe of the firſt; and, in like manner, the third perſon's cards over thoſe of the ſecond; ſo that in each parcel, there may be one card belonging to each perſon.

Having done this, aſk each of them in which parcel his card is, and when he has informed you, you may immediately know which card it is; for the firſt perſon's card will always be the bottom one, the ſecond perſon's the middle card, and the third perſon's the uppermoſt one, in that parcel where each ſays his card is.

This recreation may be performed with a ſingle perſon, by letting him fix on three, four, or more cards; in which caſe you muſt ſhow him as many parcels as he is to chooſe cards, and every parcel muſt conſiſt of that number, out of which he muſt fix on one; the reſt of the proceſs being then as above.

XIX.

A curious Trick upon the Cards, called the Ten Duplicates.

TAKE twenty cards, and after any one has ſhuffled them, lay them down by pairs, upon the table, with their faces uppermoſt.

Then deſire ſeveral perſons to fix their minds on different pairs, and remember of what cards they are compoſed.

You then take up all the cards in the ſame order you laid them down; and place them again, one by one, on the board, according to the order of the letters in the following table; beginning with the laſt card, which you will place at the beginning of the firſt row, the next card you will place ſo as to ſtand in the middle of the third row, the third card the ſecond in the firſt row, the fourth card the fourth in the ſame row, the fifth in the middle of this row, the ſixth at the end of the ſecond row, and ſo on.

M	U	T	U	S
D	E	D	I	T
N	O	M	E	N
R	O	R	I	S

Then, by aſking each perſon which row, or rows, the cards he choſe are in, you will be able to point them out, by only remembering the words of the above ſentence, and the order of the letters of which they are compoſed.

Thus, for example, if he ſay they are in the firſt row, you know that they muſt be the ſecond and fourth cards, becauſe the letter U occurs twice in that line.

If he ſay one is in the ſecond row, and the other in the fourth, they muſt be the fourth cards of thoſe rows; as is obvious from the recurrence of the letter I; and ſo of any other pair.

XX.

A Number of Names being written on ſeveral Cards, to tell the particular Name which any Perſon has thought on.

TAKE eight cards, and write eight different names on each of them, obſerving only, that the laſt name on each card muſt begin with one of the letters of the word DISCOVER, which letters, in the order they ſtand, anſwer to the Nos 1, 2, 3, 4, 5, 6, 7, 8.

On eight other cards, write the ſame names, with this reſtriction, that the firſt name, on each of them, muſt be taken from that card of the other parcel, the laſt name of which begins with D, the ſecond name from that of which the laſt name begins with I, and ſo on.

Then let any one chooſe a card out of the firſt eight, and, after he has fixed on a name, give it to you again; when you muſt carefully note the laſt name on it, and retain the number anſwering to the letter it begins with in your mind.

You then take the other eight cards, and, after ſhuffling them, ſhow them to the perſon, one by one, and deſire him to look for the name he has choſen.

When he ſays he has found it, you muſt look for that name which is the ſame in number from the top with the number of the card he took from the other parcel, and it will be the name he fixed on.

Thus, for example, ſuppoſe he took out the card that had the word Orpheus at the bottom of it, which, according to the order of the letters in the word DISCOVER, is the fifth; then whatever word he fixed upon (Hebe for inſtance) muſt neceſſarily be the fifth upon the card on which it is found in the other parcel.

Order of the Words in the firſt Eight Cards.

Corydon
Andromeda
Silenus
Acis
Proteus
Thyrſis
Flora
Daphnis

Pomona
Ariadne
Danae
Narciſſus
Hercules
Philomela
Caliſta
Jaſon

Arachne
Deucalion
Galatea
Thetis
Niſus
Ganymede
Cephalus
Semele

Pyramus
Polyhymnia
Circe
Pſyche
Caſſandra
Adonis
Icarus
Ceres

Iphigenia
Procris
Thiſbe
Diana
Hebe
Endymion
Meduſa
Orpheus

Acteon
Sappho
Alcinous
Ulyſſes
Atys
Proſerpine
Dryope
Vertumnus

Homer
Polypheme
Æneas
Heſiod
Cupid
Telemachus
Venus
Æſon

Virgil
Priam
Andromache
Euryalus
Helen
Pandora
Troilus
Rhadamanthus

Order of the Words in the laſt Eight Cards.

Corydon
Pomona
Arachne
Pyramus
Iphigenia
Acteon
Homer
Virgil

Andromeda
Ariadne
Deucalion
Polyhymnia
Procris
Sappho
Polypheme
Priam

Silenus
Danae
Galatea
Circe
Thiſbe
Alcinous
Æneas
Andromache

Acis
Narciſſus
Thetis
Pſyche
Diana
Ulyſſes
Heſiod
Euryalus

Proteus
Hercules
Niſus
Caſſandra
Hebe
Atys
Cupid
Helen

Thyrſis
Philomela
Ganymede
Adonis
Endymion
Proſerpine
Telemachus
Pandora

Flora
Caliſta
Cephalus
Icarus
Meduſa
Dryope
Venus
Troilus

Daphnis
Jaſon
Semele
Ceres
Orpheus
Vertumnus
Eſon
Rhadamanthus

Inſtead of eight cards, you may, by adding duplicates to each, have ſixteen in each parcel, which will make the recreation appear the more myſterious, without in the leaſt embarraſſing it, as you have nothing to remember but the laſt name on each card. Or, inſtead of names, you may write queſtions on one parcel, and anſwers on the other.

XXI.

To place nine Cards, in three Ranks, ſo that all the Pips of each Rank, taken either lengthwiſe, breadthwiſe, or diagonally, may make the ſame Sum.

4	9	2
3	5	7
8	1	6

TAKE an ace of any ſuit, and the next eight cards in order, and place them as in the figure; and they will be diſtributed as required.

This is called a magic ſquare, from the great veneration it was held in by the Egyptians, and other eaſtern nations, who attributed many virtues to numbers diſpoſed in this way. But, as they are now conſidered only as ingenious recreations, another inſtance or two of this kind will be ſufficient.

The firſt twenty-five numbers, diſpoſed in the form of a magic ſquare, ſo that the ſum of any rank ſhall be 65, is ſhown in the following figure:

11	24	7	20	3
4	12	25	8	16
17	5	13	21	9
10	18	1	14	22
23	6	19	2	15

Again, the firſt 100 numbers diſpoſed in the form of a magic ſquare, ſo that the ſum of any rank ſhall be 505, is thus:

10	92	93	7	5	96	4	98	99	1
11	19	18	84	85	86	87	13	12	90
71	29	28	77	76	75	24	23	22	80
70	62	63	37	36	35	34	68	69	31
41	52	53	44	46	45	47	58	59	60
51	42	43	54	56	55	57	48	49	50
40	32	33	67	65	66	64	38	39	61
30	79	78	27	26	25	74	73	72	21
81	89	88	14	15	16	17	83	82	20
100	9	8	94	95	6	97	3	2	91

There are ſeveral methods of filling up magic ſquares, but there is no one eaſier than the following, for any odd number of terms in the arithmetical progreſſion, 1, 2, 3, 4, &c. Place the leaſt term, 1, in the cell immediately under the middle, or central one, and the reſt of the terms, in their natural order, in a deſcending diagonal direction, till they run off, either at the bottom or on the ſide. When the number runs off at the bottom, carry it to the uppermoſt cell, that is unoccupied, of the ſame column as it would have fallen in below, and then proceed deſcending diagonalwiſe again as far as you can, or till the numbers either run off at bottom or ſide, or are interrupted by arriving at a cell already filled. Now when any number runs off at the right-hand ſide, bring it to the fartheſt cell on the left-hand of the ſame row or line it would have fallen in towards the right-hand; and when the progreſs diagonalwiſe is interrupted by meeting with a cell already occupied by ſome other number, then deſcend diagonally to the left from this cell till you meet with an empty one, where enter it, and thence proceed as before. Both the ſquares of odd numbers here given are filled up in this method.

XXII.

How to part an Eight Gallon Bottle of Wine equally between two Perſons, uſing only two other Bottles, one of Five Gallons, and the other of Three.

THIS queſtion is uſually propoſed in the following manner: A certain perſon having an eight gallon bottle filled with excellent wine, is deſirous of making a preſent of half of it to one of his friends; but as he has nothing to meaſure it out with but two other bottles, one of which contains five gallons, and the other three, it is required to find how this may be accompliſhed.

In order to anſwer the queſtion, let the eight gallon bottle be called A, the five gallon bottle B, and the three gallon C; then, if the liquor be poured out of one bottle into another, according to the manner denoted in either of the two following examples, the propoſed conditions will be anſwered.

8	5	3	8	5	3
A	B	C	A	B	C
8	0	0	8	0	0
3	5	0	5	0	3
3	2	3	5	3	0
6	2	0	2	3	3
6	0	2	2	5	1
1	5	2	7	0	1
1	4	3	7	1	0
4	4	0	4	1	3

XXIII.

A Quantity of Eggs being broken, to find how many there were, without remembering the Number.

An old woman, carrying eggs to market in a baſket, met an unruly fellow, who broke them. Being taken before a magiſtate, he was ordered to pay for them, provided the woman could tell how many ſhe had; but ſhe could only remember, that in counting them into the baſket by twoes, by threes, by fours, by fives, and by ſixes, there always remained one; but in counting them in by ſevens, there were none remaining. Now, in this caſe, how was the number to be aſcertained?

This is the ſame thing as to find a number, which being divided by 2, 3, 4, 5, and 6, there ſhall remain 1, but being divided by 7, there ſhall remain nothing; and the leaſt number, which will anſwer the conditions of the queſtion, is found to be 301, which was therefore the number of eggs the old woman had in her baſket.

XXIV.

To find the leaſt Number of Weights that will weigh from One Pound to Forty.

THIS problem may be reſolved by means of the geometrical progreſſion, 1, 3, 9, 27, 81, &c. the property of which is ſuch, that the laſt number is twice the ſum of all the reſt, and one more; ſo that the number of pounds being forty, which is alſo the ſum of 1, 3, 9, 27, theſe four weights will anſwer the purpoſe required.

Suppoſe it was required, for example, to weigh eleven pounds by them: you muſt put into one ſcale the one-pound weight, and into the other the three and nine-pound weights, which, in this caſe, will weigh only eleven pounds, in conſequence of the one-pound weight being in the other ſcale; and therefore, if you put any ſubſtance into the firſt ſcale, along with the one-pound weight, and it ſtand in equilibrio with the 3 and 9 in the other ſcale, you may conclude it weighs eleven pounds.

In like manner, to find a fourteen-pound weight, put into one of the ſcales the one, three, and nine-pound weights, and into the other that of twenty-ſeven pounds, and it will evidently outweigh the other three by fourteen pounds; and ſo on for any other weight.

XXV.

How to diſcover whether a piece of Money be good or bad.

TAKE another piece of the ſame metal, of equal weight with the former, and tye both of them with a piece of thread, or a horſe-hair, to ſcales of an exact balance, ſo that the two pieces may fall into a veſſel of water. Then, if they be of equal goodneſs, they will be perfectly in equilibrio in the water, as well as in the air; but if the piece in queſtion be lighter in the water than the other, it is a certain proof that it has been mixed with a baſer metal, of leſs ſpecific gravity: and if the piece to be tried is ſilver, it's weighing heavier than the other in water is alſo a proof of it's having been mixed with a metal of a greater ſpecific gravity, ſuch, for inſtance, as lead.

XXVI.

To break a Stick which reſts upon two Wine Glaſſes, without injuring the Glaſſes.

TAKE a ſtick, A B, FIG. 2, of about the ſize of a common broomſtick, and lay it's two ends, A B, which ought to be pointed, upon the edges of two glaſſes, placed upon two tables of equal height, ſo that it may reſt lightly upon the edge of each glaſs. Then take a kitchen poker, or a large ſtick, and give the other a ſmart blow, near the middle point C, and the ſtick A B will be broken without in the leaſt injuring the glaſſes: and, even if the glaſſes be filled with wine, not a drop of it will be ſpilt, if the operation be properly performed.

But, on the contrary, if the ſtick were ſtruck on the under ſide, ſo as to drive it up into the air, the glaſſes would be infallibly broken.

XXVII.

A number of Metals being mixed together in one Maſs, to find the Quantity of each of them.

VITRUVIUS, in his Architecture, reports, that Hiero, king of Sicily, having employed an artiſt to make a crown of pure gold, which was deſigned to be dedicated to the gods, ſuſpected that the goldſmith had ſtolen part of the gold, and ſubſtituted ſilver in the place of it: being deſirous of diſcovering the cheat, he propoſed the queſtion to Archimedes, deſiring to know if he could, by his art, diſcover whether any other metal were mixed with the gold. This celebrated mathematician being ſoon afterwards bathing himſelf, obſerved, that as he entered the bath the water aſcended and flowed out of it; and as he came out of it the water deſcended in like manner; from which he inferred, that if a maſs of pure gold, ſilver, or any other metal, were thrown into a veſſel of water, the water would aſcend in proportion to the bulk of the metal. Being intenſely occupied with the invention, he leaped out of the bath, and ran naked through the ſtreets, crying, "I have found it, I have found it."

The way in which he applied this circumſtance to the ſolution of the queſtion propoſed was this: he procured two maſſes, the one of pure gold, and the other of pure ſilver, each equal in weight to the crown, and conſequently of unequal magnitudes; then immerſing the three bodies ſeparately in a veſſel of water, and collecting the quantity of water expelled by each, he was preſently enabled to detect the fraud; it being obvious, that if the crown expelled more water than the maſs of gold, it muſt be mixed with ſilver or ſome baſer metal. Suppoſe, for inſtance, in order to apply it to the queſtion, that each of the three maſſes weighed eighteen pounds; and that the maſs of gold diſplaced one pound of water, that of ſilver a pound and a half, and the crown one pound and a quarter only: then ſince the maſs of ſilver diſplaced half a pound of water more than the ſame weight of gold, and the crown a quarter of a pound more than the gold, it appears, from the rule of proportion, that half a pound is to eighteen pounds, as a quarter of a pound is to nine pounds; which was, therefore, the quantity of ſilver mixed in the crown.

Since the time of Archimedes ſeveral other methods have been deviſed for ſolving this problem; but the moſt natural and eaſy is that of weighing the crown both in air and water, and obſerving the difference.

XXVIII.

To make a mutual Exchange of the Liquor in two Bottles, without uſing any other Veſſel.

TAKE two bottles, which are as nearly equal as poſſible, both in neck and belly, and let one be filled with oil, and the other with water; then clap the one that is full of water dexterouſly upon the other, ſo that the two necks ſhall exactly fit each other; and as the water is heavier than the oil, it will naturally deſcend into the lower bottle, and make the oil aſcend into it's place.

In order to invert the bottle of water without ſpilling the contents, place a bit of thin writing paper over the mouth of the bottle, and when you have placed the bottle in the proper poſition, draw out the paper quickly and ſteadily.

XXIX.

How to make a Peg that will exactly fit three different Holes.

LET one of the holes be circular, the other ſquare, and the third an oval; then it is evident, that any cylindrical body, of a proper ſize, may be made to paſs through the firſt hole perpendicularly; and if it's length be juſt equal to it's diameter, it may be paſſed horizontally through the ſecond, or ſquare hole; alſo, if the breadth of the oval be made equal to the diameter of the baſe of the cylinder, and it's longeſt diameter equal to the diagonal of it, the cylinder, being put in obliquely, will fill it as exactly as any of the former.

XXX.

To place three Sticks, or Tobacco Pipes, upon a Table, in ſuch a Manner that they may appear to be unſupported by any Thing but themſelves.

TAKE one of the ſticks, or pipes, A B, fig. 3, and place it in an oblique poſition, with one of it's ends, B, reſting on the table; then put one of the other ſticks, as C D, acroſs this in ſuch a manner that one end of it, D, may be raiſed, and the other touch the table at C. Having done this, take the third ſtick E, and complete the triangle with it, making one of it's ends E reſt on the table, and running it under the ſecond, C D, in ſuch a manner that it may reſt upon the firſt, A B, then will the three ſticks, thus placed, mutually ſupport each other; and even if a ſmall weight be laid upon them, it will not make them fall, but ſtrengthen and keep them firmer in their poſition.

XXXI.

How to prevent a heavy Body from falling, by adding another heavier Body to it on that Side towards which it inclines.

ON the edge of a ſhelf, or table, or any other horizontal ſurface, lay a key, C D, fig. 4, in ſuch a manner, that being left to itſelf, it would fall to the ground; then in order to prevent this, take a crooked ſtick D F G, with a weight H at the end of it; and having inſerted one end of the ſtick in the open part of the key, at D, let it be ſo placed, that the weight H may fall perpendicularly under the edge of the table, and the body by theſe means will be effectually prevented from falling.

The ſame thing may be done by hanging a weight at the end of a tobacco pipe, a ſtick, or any other body, the beſt means of accompliſhing which will be eaſily known by a few trials.

XXXII.

To make a falſe Balance, that ſhall appear perfectly juſt when empty, or when loaded with unequal Weights.

TAKE a balance D C E, fig. 5, the ſcales and arms of which are of ſuch unequal weights and lengths, that the ſcale A may be in proportion to the ſcale B, as the length of the arm C E is to the length of the arm C D; then will the two ſcales be exactly in equilibrio about the point C; and the ſame will be the caſe, if the two arms C D, C E, are of equal length, but of unequal thickneſs, provided the thickneſs of C D is to that of C E, as the weight of the ſcale B is to that of A.

For example, ſuppoſe the arm C D is equal to three ounces, and the arm C E, to two, and that the ſcale B weighs three ounces, and the ſcale A two; then the balance, in this caſe, will be exactly true when empty; and if a weight of two pounds be put into the ſcale A, and one of three pounds into B, they will ſtill continue in equilibrio. But the fallacy in this, and all other caſes of the ſame kind, may be eaſily detected by ſhifting the weights from one ſcale to the other.

XXXIII.

How to lift up a Bottle with a Straw, or any other ſlight Subſtance.

TAKE a ſtraw, A B, fig. 6, which is not broken or bruiſed, and bend one end of it into a ſharp angle A B C; then if this end of the ſtraw be put into the bottle, ſo that the bent part of it may reſt againſt either of it's ſides, you may take the other end in your hand, and lift up the bottle by it without breaking the ſtraw; and this will be the more eaſily done according as the angular part of the ſtraw approaches nearer to that which comes out of the bottle.

XXXIV.

How to make a Cone, or Pyramid, move upon a Table without Springs or any other artificial Means.

TAKE a cone, or pyramid, of paper, or any other light ſubſtance, and put a beetle, or ſome ſuch ſmall inſect, privately under it; then, as the animal will naturally endeavour to free itſelf from its captivity, it will move the cone towards the edge of the table, and as ſoon as it comes there, will immediately return for fear of falling; and by moving backwards and forwards in this manner, will occaſion much diverſion to thoſe who are ignorant of the cauſe.

XXXV.

To make a Pen, which holds one hundred Sheep, hold double the Number, by only adding two Hurdles more.

IN the firſt pen, or that which holds one hundred ſheep, the hurdles muſt be ſo diſpoſed that there ſhall be only one at the top and bottom, and the reſt in equal numbers on each ſide; then it is obvious, that if one hurdle more be placed at each end, the ſpace encloſed muſt neceſſarily be double the former, and conſequently will hold twice the number of ſheep.

XXXVI.

To make a Perſon chooſe any Card you pleaſe, and to tell him the Card he has choſen.

SPREAD a pack of cards before any perſon in company in ſuch a manner that one of the pictured cards, or ſome other remarkable one, only ſhall be completely viſible; then deſire him to think of any card he pleaſes; and when he has made his choice, you may ſafely tell him, that the pictured card is the one he thought on; for as no other could ſtrike his eye, it was ſcarcely poſſible for him to make a different choice; but if he ſhould, you may pretend to have made ſome miſtake, and, after a time, try the experiment with ſome other perſon in company.

XXXVII.

To diſcover any Card in the Pack by it's Weight or Smell.

DESIRE any perſon in company to draw a card from the pack, and when he has looked at it, to return it to you with the face downwards; then pretending to weigh it nicely, take notice of any particular mark on the back of the card, which having done, put it among the reſt of the cards, and deſire the perſon to ſhuffle them as much as he pleaſes; then, giving you the pack, you pretend to weigh each card as before, and proceed in this manner till you have diſcovered the card he has choſen.

XXXVIII.

A Trick on the Cards, called the two Convertible Aces.

By means of a little ſoap, fix a heart on the ace of clubs, and a club on the ace of hearts, in ſuch a manner that they will eaſily ſlip off. Show theſe two aces to the company, and taking the ace of clubs in your hand, deſire a perſon to put his foot upon it, and as you place it on the ground, draw away the club in as ſecret a manner as poſſible. In like manner place the ſeeming ace of hearts under the foot of another perſon. You then command, with as much ceremony as you choose, the two cards to change their places; and upon the perſons taking up their cards, they will have ocular demonſtration that your commands have been obeyed.

A ſimilar experiment may be practiſed with the ſeeming ace of hearts only, as follows: after ſhowing a perſon the card, let him hold one end of it at the ſame time you have hold of the other; and while you amuſe him by diſcourſe, or ſome other way, ſlide off the heart, and then laying the card on the board, with it's face downwards, knock under the table, and command it to change to the ace of clubs; which, upon it's being taken up, will be found to be the caſe.

XXXIX.

A curious Trick of Legerdemain, called the two Convertible Coins.

Take two guineas, which may be counterfeits, and two ſhillings, and grind part of them away on one ſide only, ſo that they may be about half the common thickneſs, and quite thin at the edge. Then rivet a guinea and a ſhilling together, and lay one of theſe double pieces, with the ſhilling uppermoſt, on the palm of your hand, at the bottom of your three firſt fingers, and the other piece, with the guinea uppermoſt, in like manner on the other hand. Having done this, bid the company take notice in which hand is the guinea, and in which the ſhilling; and as you ſhut your hands turn the pieces dextrouſly over, and when you open them again, the ſhilling and the guinea will appear to have changed places.

This, perhaps, may appear to be a very trifling trick, and ſo it certainly is when known; but by deceptions ſimilar to this, Breſlaw, Jonas, and others, excite univerſal admiration.

XL.

An ingenious Recreation called the Two Communicative Buſts.

TAKE two heads of plaſter of Paris, and place them on pedeſtals on the oppoſite ſides of a room. Then take a tin tube of an inch in diameter, and let it paſs from the ear of one head through the pedeſtal, and under the floor, to the mouth of the other, obſerving that the end of the tube, which is next the ear of one head, ſhould be conſiderably larger than that which comes to the mouth of the other.

The whole being ſo diſpoſed, that there may be no ſuſpicion of a communication, let any perſon ſpeak with a low voice into the ear of one buſt, and the ſound will be diſtinctly heard by any one who ſhall place his ear to the mouth of the other; and if there be two tubes, one going to the ear, and the other to the mouth of each head, two perſons may converſe together, by applying their mouth and ear reciprocally to the mouth and ear of the buſts, without being heard by any other perſons in the room.

XLI.

Another Recreation of the ſame Kind, called the Oracular Head.

Place a buſt on a pedeſtal in the corner of a room, and let there be two tubes, one of which goes from the mouth, and the other from the ear of the buſt through the pedeſtal and floor to an under apartment.

Then if a perſon be placed in the under room, by applying his ear to one of the tubes as ſoon as a proper ſignal is given, he will hear any queſtion that is aſked, and can immediately return an anſwer; and if wires be made to go from the under jaw and eyes of the buſt, they may be made to move at the ſame time, and by theſe means appear to deliver the anſwer.

It was by a contrivance of this kind that Don Anthonio de Moreno ſo much aſtoniſhed the celebrated knight of the woeful countenance and his facetious ſquire Sancho Panza, by reſolving certain doubts propoſed by the former concerning his adventures in the cave of Monteſinos, and the diſenchantment of my lady Dulcinea.

XLII.

How to make a Piece of Metal, or any other heavy Body, ſwim upon the ſurface of Water, like a Cork.

THE ſpecific gravity of water is inferiour to that of metals, and conſequently water, abſolutely ſpeaking, cannot ſupport a ball of iron or lead; but if this ball be flattened, and beaten out to a very thin plate, it will, if put ſoftly upon ſtill water, be prevented from ſinking, and will ſwim upon it's ſurface like any light ſubſtance. In like manner, if a fine ſteel needle, which is perfectly dry, be placed gently upon ſome ſtill water in a veſſel, it will float upon the ſurface without ſinking.

But if you would have a metallic body of large dimenſions to ſwim upon water, you muſt reduce it into a thin concave plate, like a kettle, in which caſe, as the air it contains, together with the body itſelf, weighs leſs than the ſame bulk of water, it cannot poſſibly ſink; as is evident from large copper boats, or pontoons, by which whole armies are frequently paſſed over rivers without danger.

And if this concave metallic veſſel be placed upon the water with it's mouth downwards, it will ſwim as before, and the contained air will keep the bottom of it from being wet: for that the water will not riſe into any hollow veſſel which is immerged into it, may be made evident thus;—Take a glaſs tumbler, and plunge it in water with it's mouth downwards, and you will find, when you take it out, that the inſide of the veſſel is perfectly dry, ſo that if a live coal were put there, it would not be extinguiſhed.

XLIII.

A curious Experiment to prove that Two and Two do not make Four.

Take a glaſs veſſel with a long narrow neck, which, being filled with water, will hold exactly a quart; then put into this veſſel a pint of water, and a pint of acid of vitriol, and you will preſently perceive, that the mixture will not fill the veſſel, as it did when a quart of water only was put into it. The acid of vitriol muſt be put in gradually, by little and little at a time, mixing each portion with the water before you add more, by ſhaking the bottle, and leaving the mouth of the bottle open, otherwiſe the bottle will burſt. The mixture in this caſe alſo poſſeſſes a conſiderable degree of heat, though the two ingredients, of themſelves, are perfectly cold; and this phenomenon is not to be accounted for, by ſuppoſing that the acid of vitriol is received in the pores of the water, for then, a ſmall portion of acid might be diſſolved in a large portion of water, without augmenting it's bulk, which is known not to be the caſe; but the very form of the bodies in this experiment is changed, there being, as Dr. Hook, who firſt noticed the fact, obſerves, an actual penetration of dimenſions. Chemiſtry alſo furniſhes a number of other inſtances, which ſhow, that two bodies, when mixed together, poſſeſs leſs ſpace than when they are ſeparate.

XLIV.

An ingenious Method of ſecret Writing, by means of Correſponding Spaces.

TAKE two pieces of paſteboard, or ſtiff paper, out of which cut a number of oblong figures, at different diſtances from each other, as in the following example. Keep one of theſe pieces for yourſelf, and give one to your correſpondent; and when you are deſirous of ſending him any ſecret intelligence, lay the paſteboard upon a ſheet of paper of the ſame ſize, and in the ſpaces which are cut out, write what you would have him only to underſtand, and fill up the intermediate parts of the paper with ſomething which makes with theſe words a different ſenſe. Then when your correſpondent receives this letter, by applying it to his paſteboard, he will be able to comprehend your meaning.

EXAMPLE.

| I ſhall be | much obliged to you, as reading | alone | engages my attention | at | preſent, if you will ſend me any of the | eight | volumes of the Spectator; I hope you will excuſe | this | freedom, but for a Winter's | evening | I | dont | know a better entertainment. If I | fail | to return it ſoon, never truſt me for the time | to come. |

Note. A paper of this ſort may be placed four different ways, either by putting the bottom uppermoſt, or by turning it over, by which means the ſuperfluous words may be more eaſily adapted to the ſenſe of the others. And in either of theſe caſes, this will be found a very eligible cipher, being more free from ſuſpicion than any other; but in general it will only do for ſhort meſſages.

XLV.

A curious Experiment, which depends on an optical Illuſion.

On the bottom of the veſſel, A I B D, fig. 7, place three pieces of money, as a half crown, a ſhilling, and a ſixpence, the firſt at E, the ſecond at F, and the third at G. Then let a perſon be placed with his eye at H, ſo that he can ſee no farther into the veſſel than I; and tell him, that by pouring water into the veſſel, you will make him ſee three different pieces of money, which he may obſerve are not poured in with the water.

For this purpoſe, deſire him to keep himſelf ſteady, in the ſame poſition, and pouring the water in gently, that the pieces of money may not be moved out of their places, when it comes up to K, the piece G will become viſible to him; when it comes up to L, he will ſee the two pieces G and F; and when it riſes to M, all the three pieces will become viſible; the cauſe of which is owing to the refraction of the rays of light, in their paſſage through the water; for while the veſſel is empty, the ray H I will proceed in a ſtraight line; but in proportion as it is filled with water, the ray will be bent into the ſeveral directions

N G, O F, P E, and by theſe means the pieces are rendered viſible.

XLVI.

A curious Experiment of nearly the ſame Kind as the laſt, called Optical Augmentation.

TAKE a large drinking glaſs, of a conical figure, and having put a ſhilling into it, fill the glaſs about half full with water; then place a plate on the top of it, and turn it quickly over, ſo that the water may not get out. This being done, look through the glaſs, and you will now perceive a piece of money of the ſize of half a crown; and ſomething higher up, another piece of the ſize of a ſhilling. But if the glaſs be entirely filled with water, the large piece at the bottom only will be viſible.

This phenomenon is occaſioned by your ſeeing the piece through the conical ſurface of the water, at the ſide of the glaſs, and through the flat ſurface at the top of the water, at the ſame time; for the conical ſurface dilates the rays, and makes the piece appear larger, while the flat ſurface only refracts them, and occaſions the piece to be ſeen higher up in the glaſs, but ſtill of it's natural ſize.

XLVII.

Another curious Experiment called Optical Subtraction.

AGAINST the wainſcot of a room fix three ſmall pieces of paper, as A B C, fig. 8, about a foot and a half or two feet aſunder, at the height of your eye; and placing youſelf directly before them, about five times the diſtance from them that the papers are from each other, ſhut one of your eyes, and look at them with the other, and you will then ſee only two of thoſe papers, ſuppoſe A and B; but altering the poſition of your eye, you will now ſee the third, and one of the firſt, ſuppoſe A; and by altering it's poſition a ſecond time, you will ſee B and C, but in neither caſe all three of them together.

The cauſe of this phenomenon is, that one of the three pencils of rays, which come from theſe objects, falls on the optic nerve at D; whereas to produce diſtinct viſion, it is neceſſary that the rays of light fall on ſome part of the retina E, F, G, H.

From this experiment, the uſe of having two eyes may be eaſily perceived; for he that has only one, can never ſee three objects placed in this poſition; or all the parts of one object, of the ſame extent, without altering the ſituation of his eye.

XLVIII.

An Optical Experiment, ſhowing how to produce an artificial Rainbow.

In any room which has a window facing the ſun, ſuſpend a glaſs globe, filled with water, by a ſtring which runs over a pulley, ſo that the ſun's rays may fall directly upon it; then drawing the globe gradually up, when it comes to the height of about forty degrees above the horizon, you will ſee, by placing yourſelf in a proper ſituation, the glaſs tinged with a purple colour; and by drawing it gradually higher up, the other priſmatic colours blue, green, yellow, and red, will ſucceſſively appear; but after this they will all vaniſh, till the globe is raiſed to about fifty degrees, when they will again be ſeen, but in an inverted order, the red appearing firſt, and the blue, or violet, laſt; and when the globe comes up to little more than fifty-four degrees, they will intirely vaniſh.

Theſe appearances ſerve to illuſtrate the phenomena of natural rainbows, of which there are generally two, the one being about eight degrees above the other, and the order of their colours inverted, as in this experiment: the red being the uppermoſt colour in the lower bow, and the violet in the other.

An artificial Rainbow may alſo be produced as follows:

Take ſome water in your mouth, and turn your back to the ſun; then if it be blown forcibly out againſt ſome dark or ſhady place, you will ſee the drops formed by the beams of the ſun into an apparent rainbow, which, however, ſoon vaniſhes.

XLIX.

A curious Optical Illuſion, produced by Means of a concave Mirror.

TAKE a glaſs bottle A B C, fig. 9, and fill it with water to the point B; leave the upper part, B C, empty, and cork it in the common manner; place this bottle oppoſite a concave mirror, and beyond it's focus, ſo that it may appear reverſed; then if you place yourſelf ſtill farther from the mirror, the bottle will appear to you in the ſituation *a b c*.

And in this apparent bottle it is remarkable that the water which, according to the laws of catoptrics, and all other experiments of this kind, ſhould appear at *a b*, appears, on the contrary, at *b c*, the part *a b* ſeeming to be entirely empty.

And if the bottle be inverted, and placed before the mirror, as in the under part of the figure, it's image will appear in it's natural erect poſition; but the water, which is in reality at *b c*, will appear at *a b*.

And if while the bottle is inverted it be uncorked, and the water ſuffered to run gently out, it will appear, that, while the part B C is emptying, the part *a b* in the image is filling; and if, when the bottle is partly empty, ſome drops of water fall from the bottom A, towards B C, it ſeems in the image as if there were formed at the bottom of the part *a b* bubbles of air ariſing from *a* to *b*, which is the part that ſeems full.

The circumſtances moſt remarkable in this experiment are, firſt, not only to ſee an object where it is not, but alſo where it's image is not; and ſecondly, that of two objects, which are really in the ſame place, as the ſurface of the bottle and the water it contains, the one ſhould be ſeen at one place, and the other at another; and alſo that the bottle ſhould be ſeen in the place of it's image, and the water where neither it nor it's image are.

It is, however, to be noted, that if any coloured liquor be put into the bottle, inſtead of water, no ſuch illuſion will take place.

There is one phenomenon more of this kind which ought not to be omitted, for though it be common enough, it is alſo extremely pleaſing, and eaſy to be performed.

If you place yourſelf before a concave mirror, at a proper diſtance, your figure will appear inverted; and if you ſtretch out your hand toward the mirror, you will perceive another hand which ſeems to meet and join it, though imperceptible to the touch.

And if inſtead of your hand you make uſe of a drawn ſword, and preſent it in ſuch a manner that it's point may be directed towards the focus of the rays reflected by the mirror, another ſword will appear, and ſeem to encounter that in your hand. But it is to be obſerved, that to make this experiment ſucceed well, you muſt have a mirror of at leaſt a foot in diameter, that you may ſee yourſelf in part; and if you have a mirror large enough to ſee your whole perſon, the illuſion will be ſtill more ſtriking.

L.

How to make a violent Tempeſt, by means of artificial Rain and Hail.

MAKE a hollow cylinder of wood, very thin at the ſides, about eight or ten inches long, and two or three feet in diameter. Divide its inſide into five equal partitions, by means of boards of about ſix inches wide; and let there be a ſpace between them, and the wooden circle, of about one-ſixth of an inch; obſerving, that the boards are to be placed obliquely to each other.

This being done, put into the cylinder four or five pounds of leaden ſhot, of a ſize that will eaſily paſs through the opening left for this purpoſe; then turn the cylinder on it's axis, and the ſound of the machine, when in motion, will repreſent that of rain, which will increaſe with the velocity of the motion; and if a larger ſort of ſhot be uſed, it will produce the ſound of hail.

LI.

How to read Letters written in arbitrary Characters called Ciphers.

THE methods of deciphering are different in different languages: but by obſerving the following rules, you may ſoon make out any common cipher, written in Engliſh.

1. Obſerve the letters or characters that moſt commonly occur, and ſet them down for the ſix vowels, including *y*; and of theſe the moſt frequent will generally be *e*, and the leaſt frequent *u*.

2. The vowels that moſt frequently come together are *e a*, and *o u*.

3. The conſonant moſt common at the end of words is *s*, and the next frequent are *r* and *t*.

4. When two ſimilar characters come together, they are moſt likely to be the conſonants *ff*, *ll*, or *ſs*, or the vowels *ee* or *oo*.

5. The letter which precedes or follows two ſimilar characters, is either a vowel, or *l*, *m*, *n*, or *r*.

6. Begin firſt with the words that conſiſt of a ſingle letter, which will be either *a*, *i*, or *o*.

7. Then take the words of two letters, one of

which will be a vowel; and of theſe words the moſt frequent are *an*, *to*, *be*, *by*, *of*, *on*, *or*, *no*, *ſo*, *as*, *at*, *if*, *in*, *is*, *it*, *he*, *me*, *my*, *us*, *we*, *am*.

8. In words of three letters, there are moſt commonly two conſonants; and of theſe the moſt frequent are, *the*, *and*, *not*, *but*, *yet*, *for*, *tho*, *now*, *why*, *all*, *you*, *ſhe*, *his*, *her*, *our*, *who*, *may*, *can*, *did*, *was*, *are*, *has*, *had*, *let*, *one*, *two*, *ſix*, *ten*, &c.

9. The moſt common words of four letters are *this*, *that*, *then*, *thus*, *with*, *when*, *from*, *here*, *ſome*, *moſt*, *none*, *they*, *them*, *whom*, *mine*, *your*, *ſelf*, *muſt*, *will*, *have*, *been*, *were*, *four*, *five*, *nine*, &c.

10. The moſt uſual words of five letters are, *there*, *theſe*, *thoſe*, *which*, *where*, *while*, *ſince*, *their*, *ſhall*, *might*, *could*, *would*, *ought*, *three*, *ſeven*, *eight*, &c.

11. Words of two or more ſyllables frequently begin with double conſonants, or with a prepoſition, which conſiſts of a vowel joined with one or two conſonants. The moſt common double conſonants are *bl*, *br*, *dr*, *fl*, *fr*, *gl*, *gr*, *ph*, *pl*, *pr*, *ſh*, *ſp*, *ſt*, *th*, *tr*, *wh*, *wr*, &c.; and the moſt common prepoſitions are, *com*, *cor*, *de*, *dis*, *ex*, *im*, *in*, *int*, *mis*, *par*, *pre*, *pro*, *re*, *ſub*, *ſup*, *ur*, &c.

12. The double conſonants moſt frequent at the end of long words are, *ck*, *ld*, *lf*, *mn*, *nd*, *ng*, *rl*, *rm*, *rn*, *rp*, *rt*, *ſm*, *ſt*, *xt*, &c.; and the moſt common terminations are *ed*, *en*, *et*, *es*, *ex*, *ing*, *ly*, *ſon*, *ſion*, *tion*, *able*, *ence*, *ent*, *ment*, *ful*, *leſs*, *neſs*, &c.

The following is an example of a letter of this kind, written, as it is uſual, in arbitrary characters.

which may be eaſily deciphered by obſerving the foregoing rules.

Γ Δ Χ □ Ο Χ L Δ Γ Λ Γ Γ Δ + Δ Ν Ξ
— Ν = Γ Π + Ω ⊥ + Λ Ω Ω Ν Ξ — =
— Χ + Ο Σ □ Π Χ Ω Ω Λ □ □ + V Υ
Ω + Υ + = Ν — + Γ Δ + L Λ Γ + Ν
= Γ Δ + Φ Χ Γ Λ Σ + Ω Υ + Ι Ξ
Ο Φ Γ Ξ Λ Ω Γ Ν Γ Δ + Δ Ν Ξ
— Λ Ο Σ Φ Ν V + Π + Ω Ω Ι —
+ Ι Λ — + Σ Γ Ν — + L Λ Χ Ο
Ɔ Ν Ξ — Ω Χ Υ + — Γ Ɔ Ν —
Σ Χ + Υ — Λ ⊥ + Ω Ɔ Γ Δ Χ □
Χ □ Γ Δ + Ο Χ L Δ Γ Γ Δ Λ Γ + Χ
Γ Δ + — V Λ S + □ Ξ □ Ν — Ξ Ο Σ Ν
+ □ Ξ □ Ρ Ξ Χ Γ +

To decipher a writing of this ſort, you muſt firſt look for thoſe characters which moſt frequently occur, and ſet them down for the vowels as before; then obſerve the ſimilar characters which come together, but remember that two ſuch characters may belong to two words. You are next to remark the combinations of two or three of the moſt frequent characters, which will be ſome of the words in the 7th and 8th of the foregoing rules; and by proceeding in this manner with the reſt, you may infallibly diſcover, by time and proper attention, any cipher written upon theſe principles.

And the longer any letter of this kind is, the more eaſy it is to decipher it, as the repetitions of the characters and combinations will neceſſarily be more frequent.

The contents of the foregoing letter are as follows; but that they, who are deſirous of trying their talent at deciphering, may not read the explanation before the cipher, the words and letters are here put in an inverted order.

evlewt fo ruoh eht ta thgin siht, ledatic
eht fo etag eht erofeb elbmeſſa lliw sdneirf
ruo lla. ruoh eht ot lautcnup eb: deraperp
llew emoc dna, ytrebil ruoy niager ot, ylevarb
eid ro, thgin eht si siht, su sekam rehtie taht,
etiuq su seodnu ro.

The Lacedæmonians are ſaid to be the firſt inventors of ciphers, or at leaſt they were not, to our knowledge, uſed by any people before them. Their method was by rolling a narrow parchment round a wooden cylinder, called a Scytala Laconica, upon which they wrote their diſpatches. It was then taken off, and ſent to the confederate, who had another roller exactly of the ſame ſize, round which he wrapt the parchment, and then read it's contents.

LII.

A curious Hydraulic Experiment, called the Magical Bottle.

TAKE a ſmall bottle, A B, Fig. 10, the neck of which muſt be very narrow, and provide a glaſs veſſel, C D, the height of which exceeds that of the bottle about two inches; fill the bottle, by means of a ſmall funnel, with red wine, and place it in the veſſel C D, which is to be previouſly filled with water.

Then, if the bottle be uncorked, the wine will preſently come out of it, and riſe, in form of a ſmall column, to the ſurface of the water; and at the ſame time the water, entering the bottle, will ſupply the place of the wine; for water being ſpecifically heavier than wine, it will conſequently ſubſide to the loweſt place, while the other naturally riſes to the top.

A ſimilar effect will be produced, if the bottle be filled with water, and the veſſel with wine; for the bottle being placed in the veſſel, in an inverted poſition, the water will deſcend to the bottom of the veſſel, and the wine will riſe into the bottle. The ſame effect may alſo be produced by any other liquors, the ſpecific gravities of which are conſiderably different.

LIII.

Another Hydraulic Experiment, called the Miraculous Veſſel.

TAKE a tin veſſel of about ſix inches in height, and three in diameter, and having a mouth of only a quarter of an inch wide; and in the bottom of the veſſel make a number of ſmall holes, of a ſize ſufficient to admit a common ſewing needle.

Plunge the veſſel into water, with it's mouth open, and when it is full, cork it, and take it out again; then, as long as the veſſel remains corked, no water will come out of it; but as ſoon as it is uncorked, the water will immediately iſſue from the ſmall holes at the bottom.

It muſt be obſerved, however, that if the holes at the bottom of the veſſel be more than one-ſixth of an inch in diameter, or if they be too numerous, the experiment will not ſucceed; for, in this caſe, the preſſure of the air againſt the bottom of the veſſel will not be ſufficient to confine the water.

LIV.

A curious Hydraulic Experiment, called Tantalus's Cup.

TAKE a glaſs, or any other veſſel, A B C D, Fig. 11, which has a ſmall bent pipe, E F G, open at each end, running through the middle of it; then if water, or wine, be poured into the glaſs, it will continue in it till the tube is full up to the bend F, which ſhould be a little lower than the upper edge of the glaſs; but if, after this, you continue to pour more liquor into it, it will endeavour, as uſual, to riſe higher in the glaſs, but not finding room for a farther aſcent in the tube, it will deſcend through the part E G, and run out at the end G, as long as you continue to put it in. To thoſe who are unacquainted with the nature of the ſyphon, the effect may perhaps appear ſomething more extraordinary, if the longeſt branch of the tube be concealed in the handle of the cup.

This is called the cup of Tantalus, from it's reſemblance to an experiment of the ſame kind, which is ſometimes made, by placing an upright image in the cup, and diſpoſing of the ſyphon in ſuch a manner, that, as ſoon as the water riſes to the chin of the image, it will begin to run out through the longeſt leg, in the ſame manner as from the cup above-mentioned.

LV.

A curious Chymical Experiment, called the Tree of Diana.

Make an amalgam, without heat, of two drams of leaf ſilver with one dram of quickſilver. Diſſolve this amalgam in two ounces, or a ſufficient quantity, of pure nitrous acid of a moderate ſtrength: dilute the ſolution in about a pound and a half of diſtilled water, agitate the mixture, and preſerve it for uſe in a glaſs bottle with a ground ſtopper. When you would make your tree, put into a phial the quantity of an ounce of the above preparation, and add to it about the ſize of a pea of an amalgam of gold or ſilver as ſoft as butter: the veſſel muſt then be left at reſt, and ſoon afterwards ſmall filaments appear to iſſue out of the ball of amalgam, which quickly increaſe, and ſhoot out branches in the form of ſhrubs.

A metallic arboriſation, ſomewhat ſimilar, may be produced in the following manner: Diſſolve a little ſugar of lead in water, and fill a phial with the ſolution. Paſs a wire through the cork, and affix to the upper part of the wire a ſmall bit of ſilver, or zinc, in ſuch a manner that it may be immerſed in the ſolution not far from it's ſurface. Set the phial in ſome place where it may remain undiſturbed, and in about twenty-four hours you will perceive the lead beginning to ſhoot round the wire: This proceſs will continue going on ſlowly, till you have a beautiful metallic tree. If you have a wide-mouthed phial, or glaſs jar, the experiment may be pleaſingly diverſified, by arranging the wire in various forms.

LVI.

A remarkable Experiment, called Prince Rupert's Drops.

TAKE up a ſmall quantity of the melted matter of glaſs with a tube, and let a drop of it fall into a veſſel of water. This drop will have a ſmall tail, which being broken, the whole ſubſtance of the drop will burſt, with great violence, into a fine powder, and give a little pain to the hand, but do no hurt to it.

It is a remarkable circumſtance in this experiment, that the bulb, or body, will bear the ſtroke of a hammer, without breaking; but when the tail is broken, the above-mentioned effect is produced. If the drop be cooled in the air, the ſame effect will not take place; and if it be ground away on a ſtone, nothing extraordinary appears; but if it be put into the receiver of an air pump, and then broken, the effect will be ſo violent as to produce light.

LVII.

How to make Sympathetic Inks, of various Kinds.

BY ſympathetic inks are meant thoſe kinds of liquors, with which if any characters be written, they will remain inviſible, till ſome method is uſed to give them a colour.

The firſt claſs of theſe inks conſiſts of ſuch as become viſible by paſſing another liquor over them, or by expoſing them to the vapour of that liquor.

The ſecond, of thoſe which do not appear ſo long as they are kept cloſe, but ſoon become viſible on being expoſed to the air.

The third, of ſuch as become apparent, by ſtrewing or ſifting ſome very fine powder over them.

The fourth, of thoſe which do not become viſible, till they are expoſed to the fire, or heated.

The fifth, like the fourth, of ſuch as appear by heat, but diſappear again when the paper becomes cold, or has had a ſufficient time to imbibe the moiſture of the air.

Sympathetic Inks of the Firſt Claſs.

PUT ſome litharge into ſtrong diſtilled vinegar, and let it ſtand for twenty-four hours; then ſtrain it off, and after it is quite ſettled, put it into a bottle cloſely corked, and preſerve it for uſe. Having done this, put into a pint bottle two ounces of quick lime, one ounce of orpiment in powder, and as much water as will riſe two or three fingers breadth above them; and when the ſolution is made, pour the liquor gently off, and let it ſtand in the ſun for two or three days, obſerving to turn it five or ſix times each day.

When theſe liquors are ready for uſe, any letters written by the firſt, being expoſed to the vapours of the ſecond, will quickly become viſible; and if you would have them diſappear again, you muſt draw a ſponge, or pencil, dipt in aqua fortis, or ſpirit of nitre, over them: and if after this you would have them appear again, ſtay till the paper is quite dry, and then paſs the vivifying liquor, made of the ſolution of orpiment, over them as before.

Another Ink of this Claſs.

DISSOLVE biſmuth in the nitrous acid, and any letters written with this ink will become quite black, by being expoſed to the vapour of liver of ſulphur, which is of ſo penetrating a nature, that it will act upon the ink through a quire of paper, or even the ſlight partition of a room.

A Sympathetic Gold Ink, of the Second Claſs.

PUT as much gold into a ſmall quantity of aqua regia as will juſt diſſolve it, and then dilute it with two or three times as much diſtilled water.

Alſo diſſolve, in a ſeparate veſſel, fine pewter in aqua regia, and when it is well ſaturated, add to it an equal quantity of diſtilled water.

Then, if any characters be written with the ſolution of gold, put them in the ſhade till they become quite dry, and they will not appear for the firſt ſeven or eight hours; but if you dip a pencil, or ſmall fine ſponge, in the ſolution of pewter, and draw it lightly over the inviſible characters, they will preſently appear of a purple colour.

The purple colour of theſe letters may be effaced again, by wetting them with aqua regia, and may be produced a ſecond time, by paſſing the ſolution of pewter over them as before.

A Sympathetic Silver Ink, of the Second Claſs.

DISSOLVE fine ſilver in aqua fortis, and add ſome diſtilled water to the ſolution, in the ſame manner as in the gold ink; then, whatever is written with this ink, will remain inviſible for three or four months, if it be kept cloſe from the air; but if it be expoſed to the ſun, it will appear, in about an hour, of a gray colour, like that of a ſlate.

Sympathetic Inks of the third claſs, or ſuch as become viſible by having any fine powder ſtrewed over them, may be compoſed of the glutinous and colourleſs juice of any vegetable, the milk of animals, and ſeveral other ſubſtances.

Sympathetic Inks, of the fourth claſs, are made by diluting acid of vitriol with about three times it's weight of common water, or as much as will prevent it from corroding the paper. The juice of lemons, or onions, will anſwer the ſame purpoſe, but either of them requires more heat than the firſt, and will not keep ſo long.

A Green Ink, of the Fifth Claſs.

TAKE zaffre in powder, and let it remain diſſolved in aqua regia for twenty-four hours; after which pour the liquor off clear, and adding to it as much common water, keep it in a bottle well corked. Then, if any characters be written with this ink, and expoſed to the fire, or ſtrong rays of the ſun, they will appear of a lively green.

It is the peculiar property of this ink, that as ſoon as the paper becomes cold again, the letters will diſappear, and this alternate appearance and diſappearance may be repeated a great number of times, provided the heat be not too great.

Other ſympathetic Inks.

A YELLOW ink of this kind may be made, by ſteeping the flowers of marygolds ſeven or eight days in clear diſtilled vinegar, and then preſſing them out, and keeping the liquor well corked in a bottle for uſe.

For a red inviſible ink, take the pure ſpirit of vitriol, or that of nitre, and add to it eight or ten times as much water, according as you would have it more or leſs red.

For a green ink of this ſort, diſſolve ſalt of tartar, the cleareſt and drieſt you can procure, in a ſufficient quantity of river water; *and for a violet ſympathetic ink*, expreſs the juice of lemons, and keep it in a bottle well corked.

Then, if any characters be written with one of theſe inks, they will appear in their proper colours, after having been dipped in the following liquor.

Take a ſufficient quantity of the flowers of panſies, or common violets, and after adding ſome water to them, ſtrain the liquor through a cloth, and keep it in a bottle for uſe.

A ſympathetic Ink which appears by being wetted with Water.

MIX alum with a ſufficient quantity of lemon juice; then, if any letters or characters be written with this mixture, they will be inviſible till they are wetted with water, which will make them appear of a greyiſh colour, and quite tranſparent.

Or you may write with a ſtrong ſolution of roch alum only, and when the writing is dry, pour a ſmall quantity of water over it, and it will appear of a white colour, like that of the paper before it was wetted.

Alſo all ſaline liquors, ſuch as vitriolic, nitrous, and marine acids, diluted with water; the liquor of fixed vegetable alkalis, and even vinegar, will produce the ſame effect.

Note, If a little aqua fortis be mixed with the water, the writing will dry well, and not run out of it's form when the paper is wetted.

LVIII.

A curious Recreation with ſympathetic Ink, called the Book of Fate.

MAKE a book, conſiſting of ſeventy or eighty leaves, and in the cover at the end of it, let there be a caſe which opens next to the back, that it may not be perceived. At the top of each right hand page, write any queſtion you pleaſe, and at the beginning of the book, let there be a table of thoſe queſtions, with the number of the pages in which each are to be found. Then write with common ink on ſeparate papers, each about half the ſize of the pages, the ſame queſtions that are in the book; and under each of them, write with the ink made with the litharge of lead, or the ſolution of biſmuth, the anſwer.

Soak a double paper in the vivifying ink, made of quick lime and orpiment, or the liver of ſulphur, and juſt before you make the experiment, place it in the caſe that is in the cover of the book.

Having done this, deliver ſome of the papers on which the queſtions are written, to the company; and after they have choſen ſuch as they wiſh to have anſwered, let them put them into thoſe leaves where the ſame queſtions are contained; then ſhutting the book for a few minutes, the ſulphureous ſpirit, with which the paper in the cover of the book is impregnated, will penetrate the leaves, and make the anſwer viſible, which will be of a brown colour, and more or leſs deep, in proportion to the time the book has been cloſed.

LIX.

A curious Recreation, called the Tranſcolorated Writing.

WRITE on a paper, with a violet coloured liquor, as many letters or words as you pleaſe, and aſk any perſon which he will chooſe to have the writing, yellow, green, or red. When he has made his choice, have a ſponge ready, with three ſides, which you can eaſily diſtinguiſh, and dip each of it's ſides in one of the three ſympathetic inks; then draw the ſide of the ſponge, which correſponds to the colour the perſon has choſen, over the writing, once only, and it will directly change to the colour required.

LX.

An Experiment with ſympathetic Ink, called the Oracular Letters.

WRITE on ſeveral ſlips of paper different queſtions, and ſuch as may be anſwered by the name of ſome perſon;—for example, Who is the merrieſt man in company? *Anſwer*. Mr. * * *. To whom will Miſs * * * * be married? *Anſwer*. To Mr. * * *. Theſe queſtions are to be written in the ſympathetic ink of the fourth claſs, and expoſed to the fire, and the anſwers written in the ſame ink, and left inviſible. The papers are then to be folded in the form of letters, and in ſuch a manner, that the part where the name is written ſhall be directly under the ſeal; in which caſe, the heat of the wax will make it viſible. Then, if the letter be given to the perſon who requires the anſwer, he will find it plainly written.

A recreation ſimilar to this may be made with a number of blank cards, on each of which an ace of clubs is drawn with inviſible ink. Then let a perſon chooſe any one of them, and encloſe it in a letter-caſe, ſo prepared, that the figure of the ace may be directly under the ſeal; and on opening the letter, it will be immediately viſible.

LXI.

An Experiment with ſympathetic Ink, called Winter changed to Spring.

TAKE a print which repreſents Winter, and trace over the trees, plants, and ground, with the green ſympathetic ink; obſerving to make ſome parts deeper than others, according to their diſtance. When thoſe parts are dry, paint the other objects in their natural colours; then put the print into a glazed frame, and cover the back of it with a paper, paſted over it's border only.

When this print is expoſed to the heat of a moderate fire, or to the warm rays of the ſun, all the graſs and foliage will turn to a pleaſing green; and if a yellow tint be given to ſome parts of the print, before the ſympathetic ink be drawn over it, the green will be of different ſhades, and the ſcene, that a minute before repreſented Winter, will now be changed into Spring. When this print is placed in the cold, Winter will appear again, and be again driven away by the warm rays of the ſun; and this alternate change of ſeaſons may be repeated as often as you pleaſe, provided the print be not made too hot.

LXII.

A remarkable Experiment, called the Revivified Roſe.

TAKE a roſe that is quite faded, and throw in ſome common ſulphur on a chafing diſh of hot coal. Hold the roſe over the fumes, and it will become quite white; then dip it into a baſon of water, and giving it to any one, tell him to put it into his box or drawer, and after locking it, to give you the key. About five or ſix hours afterwards, return him the key, and when he unlocks his drawer, inſtead of the white roſe he put into it, he will find one perfectly red.

LXIII.

How to Write on Glaſs, by means of the Rays of the Sun.

DISSOLVE chalk in aqua fortis to the conſiſtence of milk, and add to it a ſtrong ſolution of ſilver; keep this liquor in a glaſs decanter, well ſtopped, and cutting out from a paper the letters you wiſh to appear, paſte it on the decanter, and place it in the ſun, in ſuch a manner, that it's rays may paſs through the ſpaces cut out of the paper, and fall on the ſurface of the liquor; then will that part of the glaſs through which the rays paſs be turned black, while that under the paper will remain white; but particular care muſt be taken that the bottle be not moved during the time of the operation.

LXIV.

To produce different Colours, by pouring a colourleſs Liquor into a clean Glaſs.

TAKE a ſtrong ſolution of quickſilver, made with ſpirit of nitre; dilute it with water, and pour it into a hot glaſs, rinced in ſtrong ſpirit of ſea ſalt, and it will inſtantly become coloured. Or if a ſolution of ſilver, made with ſpirit of nitre, conſiderably diluted, be poured into a glaſs, prepared in the manner abovementioned, it will produce the ſame effect. And if you pour hot water upon new made crocus metallorum, and put it into a clean glaſs, rinced with any acid, it will produce an orange colour.

LXV.

To produce a Colour which appears and diſappears by the Influence of the Air.

PUT into a decanter ſome volatile ſpirit, in which you have diſſolved copper filings, and you will have a fine blue tincture; and if the bottle be ſtopped, the colour will preſently diſappear; but when it is unſtopped, the colour will ſoon return again; and this experiment may be repeated a conſiderable number of times.

LXVI.

To turn a colourleſs Liquor Black, by adding a White Powder to it.

PUT a hot weak pellucid infuſion of galls into a glaſs, and throw into it a grain of the vitriol of iron, calcined to whiteneſs, and conſiderably heated; then, as it falls to the bottom, it will make a black cloud, which will uniformly diffuſe itſelf through the tranſparent liquor and gradually turn it black.

The ſame effect may alſo be produced by the addition of a little vitriol of iron calcined to a yellow colour, or by the colcothar of vitriol calcined to redneſs.

The black liquor, produced as above, may be rendered pellucid again, by pouring the liquor hot into a glaſs rinced with the pure acid of vitriol. And to make this tranſparent liquor black again, pour to it as much hot oil of tartar per deliquium as will ſaturate the acid, which has attracted the metallic matter.

LXVII.

A curious Pyrotechnical Experiment, with Liquid Phoſphorus.

TAKE a piece of common phoſphorus, of about the ſize of a pea, and cutting it very ſmall, put it into a glaſs of clear water, and boil it in a little earthen veſſel over a moderate fire. Then take a phial with a narrow neck, and having plunged it into boiling water, take it out again, and put the boiling mixture immediately into it, ſtopping the phial inſtantly with a glaſs ſtopper, and covering it with a cement, that the air may in no degree enter.

Then, if this mixture be put in a dark room, it will ſhine for ſeveral months, though the phial be not touched; but if it be ſhaken, eſpecially in warm dry weather, very ſtrong corruſcations like lightning, will dart from the middle of the water; and if the phial be ſufficiently long, or broad, and a piece of paper be paſted over it, any letters or figures which may be written on it, will appear ſtrongly illuminated.

Note, If any letters or figures be drawn with it on a white wall, in a dark room, they will likewiſe appear luminous.

LXVIII.

Another Pyrotechnical Experiment, by means of Fulminating Powder.

TAKE three parts of nitre, two parts of ſalt of tartar perfectly dry, and one part of flowers of ſulphur. Mix them well together by rubbing them in a mortar, taking care that they do not attract any moiſture from the air, which they will do if expoſed to it too long. A ſmall quantity of this powder, ten or twenty grains for inſtance, being put into a fireſhovel, and held over the fire till it begins to melt, will then produce a ſmart exploſion. No danger attends this experiment, unleſs too large a quantity of the powder be uſed, or the operator pry too cloſely into what is going forward.

LXIX.

A curious Experiment made by Mr. Symmer, on the Electricity of Silk Stockings.

THIS gentleman having frequently obſerved, that on putting off his ſtockings in the evening they made a crackling or ſnapping noiſe, and that in the dark they emitted ſparks of fire, was induced to examine on what circumſtances theſe electrical appearances depended. After a conſiderable number of obſervations, directed to this point, he found that it was the combination of white and black which produced the electricity, and that the appearances were the ſtrongeſt when he wore a white and black ſtocking upon the ſame leg.

Theſe, however, diſcovered no ſigns of electricity while they were upon the leg, though they were drawn backwards and forwards upon it ſeveral times; but the moment they were ſeparated, they were both of them found to be highly electrified, the white poſitively, and the black negatively: and when they were held at a diſtance from each other, they appeared inflated to ſuch a degree, that they exhibited the entire ſhape of the leg.

When two black or two white ſtockings were held together, they would repel one another to a conſiderable diſtance; and when a white and black ſtocking were preſented to each other, they would be mutually attracted, and ruſh together with great violence, joining as cloſe as if they had been ſo many folds of ſilk; and in this caſe their electricity did not ſeem to have been in the leaſt impaired by the ſhock of meeting, for they would be again inflated, attract, repel, and ruſh together as before.

When this experiment was performed with two black ſtockings in one hand, and two white ones in the other, it exhibited a ſtill more curious ſpectacle. The repulſion of thoſe of the ſame colour, and the attraction of thoſe of different colours, threw them into an agitation, and made each of them catch at the oppoſite colour in a way that was not unentertaining.

What was alſo very remarkable in theſe experiments, with a white and black ſtocking, was the power of electrical coheſion which they exhibited; Mr. Symmer having found that, when they were electrified and allowed to come together, they frequently ſtuck ſo cloſe to each other, that it required a weight of ſixteen or ſeventeen ounces to ſeparate them, and this in a direction parallel to their ſurfaces.

When one of the ſtockings was turned inſide out, it required twenty ounces to ſeparate them; and by having the black ſtockings new dyed, and the white ones waſhed and whitened in the fumes of ſulphur, and then putting them one within the other, it required three pounds three ounces to ſeparate them.

Trying this experiment with ſtockings of a more ſubſtantial make, he found that, when the white ſtocking was put within the black one, ſo that it's outſide was contiguous to the inſide of the other, they raiſed near nine pounds; and when the white ſtocking was turned inſide out, and put within the black one, ſo that their rough ſurfaces were contiguous, they raiſed fifteen pounds, which was ninety-two times the weight of the ſtockings. And in all theſe caſes, he found that preſſing them together with his hands contributed much to ſtrengthen the coheſion.

When the white and black ſtockings were in coheſion, and another pair, more highly electrified, were ſeparated from each other, and preſented to the former, their coheſion would be diſſolved, and each ſtocking of the ſecond pair would catch hold of and carry away with it that of it's oppoſite colour; but if the degree of electricity of both pairs were equal, the coheſion of the former would be weakened, but not diſſolved, and all the four would cohere together in one maſs.

Mr. Symmer alſo obſerved, that white and black ſilk, when electrified, not only cohered with each other, but would alſo adhere to bodies with broad, and even poliſhed ſurfaces, though thoſe bodies were not electrified. This he diſcovered, by throwing accidentally a ſtocking out of his hand, which ſtuck to the paper-hangings of the room; and which, in another experiment of this kind, continued hanging there for near an hour.

Having ſtuck up the black and white ſtockings in this manner, he came with another pair of ſtockings, highly electrified, and applying the white to the black, and the black to the white, he carried them off from the wall, each of them hanging to that which had been brought to it. The ſame experiment alſo held with the painted boards of the room, and likewiſe with the looking-glaſs, to the ſmooth ſurface of which the white and black ſtockings appeared to adhere more tenaciouſly than to either of the former.

THE END.

6 FE 67

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